

# ION BEAM DEPOSITION TARGETS HAVING AN INTERLOCKING INTERFACE AND A REPLACEABLE INSERT

## BACKGROUND OF THE INVENTION

### Priority Claim

This application claims the benefit of U.S. Provisional Application No. 60/247,427, filed November 9, 2000.

### Field of the Invention

The invention relates generally to a target source for thin film sputter deposition, and more particularly to an ion beam deposition target source having an interlocking interface and a replaceable inner central insert.

### Description of the Prior Art

Sputter deposition processes that use ion beam target sources are found in a variety of applications. Sputter deposition is one of several well known techniques for applying or depositing a thin layer on a substrate. In ion beam bombardment sputtering, a high energy source of ions is directed toward a target source. The force of the bombardment of ions imparts sufficient energy to the atoms of the target source to cause the energized atoms to leave the target source, form a particle flux, and deposit a thin film on a substrate. The advantages of using ion beam sputter deposition include isolation of the substrate from energetic electron bombardment and independent control over the ion energy and current density striking the target. The basic techniques of ion beam sputter deposition are well known in the art.

Generally, any target source material that can be physically placed in a vacuum chamber can be sputtered by ion beam deposition. This includes materials comprised of a single chemical element, alloys, composites, and compounds. In depositing a thin film of a given chemical

composition, where the target source is relied on as a primary source of deposition material, the target source can be prepared by vacuum, inert, or open atmosphere melting. The material is melted by induction, resistive, electric arc, or similar melting methods. The material is subsequently formed into an appropriate shape through known material processing methods.

5 Alternatively, the material may be formed by a number of powder consolidation methods such as press and sinter, hot isostatic pressing, uniaxial hot pressing or similar well-known techniques.

These methods can be designed to produce material of a high purity and structural integrity.

Deposition targets are typically attached to a backing holder or plate by a bonding layer for accurate placement in the vacuum chamber. The bonding layer usually comprises solder. US

10 Patent No. 4,430,190 to Eilers et al. discloses an example of a deposition target source bonded to a backing holder or plate.

Other factors that can affect the rate and extent of erosion of a deposition target source include the intensity, direction and size of the ion beam used in the sputtering process. However, because the diameter of the ion beam is generally smaller than the dimensions of the deposition target source used, excessive erosion typically occurs on the region of the target source that is directly impacted by the ion beam (typically the center region), while the region of the target

source not hit by the ion beam (typically the outer region) demonstrates little to no erosion.

Thus, the eroded region will generally correspond to the dimensions of the ion beam bombarding the region.

## 20 SUMMARY OF THE INVENTION

In part because of the very high costs of many deposition materials, such as tantalum and precious metals, there is currently a need for producing ion beam deposition target sources that are significantly lower in cost. We have solved this and related problems by producing ion beam deposition target sources that have a replaceable insert which is centrally located to correspond to

the region eroded by the ion beam. By developing a deposition target source having a replaceable insert, the region of the target source not eroded by the ion beam can remain in place attached to the holder or frame supporting the target. The ability to remove and replace only the insert portion of the deposition target source eroded by the ion beam saves time and has economic benefits such as reducing the costs associated with materials used to make the target, reducing the costs associated with processing and machining the target source, and permitting the reuse of the remainder of the target not eroded, rather than replacing the entire target source as is currently done.

With the present invention, the replaceable central inner insert can be removed from the vacuum chamber and replaced once eroded, while allowing the outer uneroded portion of the target source to remain attached to a backing holder or plate. Alternatively, if the entire target source and backing plate are returned to a central processing center, both the insert and the outer portion can be removed from the backing plate for inspection by melting or dissolving the bonding layer, and the same outer portion together with a new central insert attached to the backing plate by a fresh bonding layer.

Accordingly, it is a principal object of this invention to provide an ion beam deposition target source having a centrally located inner insert that can be removed and replaced when eroded, wherein the outer region of the target source not eroded by the ion beam can either remain in place attached to a backing plate located on an ion beam deposition (IBD) machine or be reused with a new central insert if the target source is to be removed for more efficient recycling. The deposition target source of the present invention comprises at least a centrally located removable inner insert completely surrounded by an outer region. The inner insert and the outer region are joined to each other to form the deposition target source by an interlocking interface to prevent contaminants, such as atoms from the bonding layer, from also being formed

in the particle flux. The deposition target source is attached by the bonding layer to a conventional backing plate located on an IBD machine. The bonding layer preferably comprises solder.

It is another object of this invention to provide an ion beam deposition target source having a geometric shape including, but not limited to, round, rectangular or oval shapes.

It is a further object of this invention to provide a reusable ion beam deposition target source wherein the outer region of the target source not eroded by the ion beam remains attached to the backing plate on an IBD machine, and/or can be reused rather than replaced along with the eroded inner insert.

It is an additional object of this invention to provide an ion beam deposition target source that requires less replacement materials because only the eroded inner insert is replaced, rather than the entire target source.

It is another object of this invention to provide an ion beam deposition target source that reduces the costs and time associated with the processing and machining of a replacement target source because only the eroded inner insert is replaced, rather than the entire target source.

These and other objects of the present invention will become readily apparent upon further review of the following specification and drawings.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is a top view of an ion beam deposition target source configuration according to the present invention;

Fig. 2 is a cross sectional view of the interlocking interface taken along line 2-2 in Fig. 1;

Fig. 3 is a top view of the deposition target source according to the present invention attached to a backing plate;

Fig. 4 is a cross sectional view taken along line 4-4 in Fig. 3;

Fig. 5 is an exploded cross sectional view of Fig. 4;

Fig. 6 is a cross sectional view of an alternative interlocking interface embodiment according to the present invention;

Fig. 7 is a cross sectional view of another alternative interlocking interface embodiment according to the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in Figs. 1-7, Fig. 1 depicts a deposition target source 20 of the present invention having an oval shape comprising a centrally located inner insert 22, an interlocking interface 24 and an outer region 26 completely surrounding the inner insert 22. The interlocking interface 24 joins the inner insert 22 and the outer region 26 by a mechanical interlocking lip or groove structure located on opposing mating surfaces of the inner insert 22 and the outer region 26. The mechanical interlocking lip or groove structure of the interface 24 is depicted in Figs. 2 and 4-7.

While Figs. 2 and 4-7 depict alternative embodiments of the interlocking lip or groove structure that comprise interface 24, it should be noted that the actual structure of interface 24 can vary, and is not limited to the structures or shapes shown. Whatever shape or structure is selected for interface 24, it must enable the opposing mating surfaces of inner insert 22 and outer region 26 to mechanically interlock, thereby forming a cohesive deposition target source 20.

In addition to providing a mechanical interlocking feature, interface 24 depicted in Figs. 2 and 4-7 also enables molten solder or other molten bonding material used to attach the target source 20 to the backing plate 30 to become trapped or contained within the lip or groove structure, preventing molten solder or other bonding material from inadvertently contaminating the front surface of the target source 20.

Figs. 3 and 4 depict target source 20 attached to a backing plate 30 of an IBD machine (not shown) by a bonding layer 40. The bonding layer 40 is preferably solder, and the target source 20 is bonded to the backing plate 30 when molten solder or bonding material constituting the bonding layer 40 solidifies, adhering the back or rear side of the target to the backing plate 30. Once the inner insert 22 becomes sufficiently eroded such that replacement is required, the backing plate 30 is heated to a temperature sufficient to melt the solder constituting the bonding layer 40, thereby permitting the removal of the eroded inner insert 22 from the backing plate 30. Upon removal of the eroded inner insert 22, a new inner insert replacement can be joined to the remaining outer region 26 by engaging the interlocking lip structure located on the opposing mating surfaces of the inner insert 22 and the outer region 26, thereby forming interface 24. The new uneroded inner insert 22 is then soldered to the backing plate 30. Alternatively, if the entire target/backing plate assembly is sent to a processing center for recycling, both inner insert 22 and outer region 26 may be removed for inspection and cleaning of outer region 26 and backing plate 30 before reattaching outer region 26 to backing plate 30 using a new insert 22.

While target source 20 is depicted in the Figs. 1-4 as having an oval shape, the target source 20 can be made into a variety of shapes and sizes, and consist of a variety of materials including, but not limited to, metal and metal alloys, composites, ceramic compounds, and other chemical compositions. In a preferred embodiment, the ion beam deposition target source 20 consists of geometric figures having the following shapes and dimensions, including, but not limited to, a round shape having a diameter from about 10" to about 16", an oval shape having a dimension of about 9" x 12", and a rectangular shape having the dimensions of about 10" x 14".

While the invention has been described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may

be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation of material to the teachings of the invention without departing from the scope of the invention. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope and spirit of the appended claims.